REPORT

ON THE

REMOVAL OF THE PUMPING STATION

AND OTHER WORK CONNECTED WITH THE

BROOKLINE WATER SUPPLY,

PRESENTED BY THE

SPECIAL COMMITTEE

AND

CONSULTING ENGINEERS.

AS AUTHORIZED BY THE TOWN, JUNE 11, 1879.

BROOKLINE:
PRESS OF T. R. MARVIN & SON.
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REPORT.

At the special town meeting holden Oct. 10, 1878, the third article of the warrant, viz., "To see if the town will examine the cause of the alleged impurity of the water supply," being under consideration, it was "*Voted*, That the subject-matter of this article be referred to a Committee consisting of Messrs. Henry M. Whitney, Willard A. Humphrey, William H. Lincoln, and the Water Board, with a request that they report at the next annual meeting the full extent of the difficulty, and the best way to remedy it, and the cost of doing it; and that the Committee have power to consult experts."

Pursuant to this vote, the Committee appointed submitted a report to the town at the annual meeting in March, 1879, with estimates, and letters bearing upon the subject, and recommended the passing of the following vote: "That the sum of $35,000 be appropriated for moving the Pumping Station to Cow Island, including new house for engineer, new relief engine and force main to connect with the force main at the present location of the Pumping Station."

At the conclusion of a lengthy discussion upon the Report, in the same meeting, without action upon the above motion, the town passed the following vote: — "That the Report be

referred back to the Committee, with instructions to secure engineering advice other than that of those whom they have already consulted; and that the sum of five hundred ($500) dollars be appropriated for that purpose.' In accordance with this vote, the Committee, after careful enquiry and correspondence, secured the services of General George S. Greene, of New York, former President of the Society of Engineers, whose report was submitted to the town in print, at a special town meeting held June 11th, 1879, and at the same meeting the following vote was passed:—"*Voted*, That the sum of $35,000 be appropriated for moving the Pumping Station to Cow Island, including new house for engineer, new relief engine and force main, to connect with the force main at the present location of the Pumping Station, and the other items included in the proposition of Messrs. Shedd & Sawyer, dated April 29, 1879, and that this sum be borrowed upon the notes of the town, to be denominated 'Brookline Water Scrip,' and that the sum of $971.71 be appropriated from the taxes of the present year for a sinking fund for the payment of the water scrip, the issue of which is, or has been authorized the present year, as by law provided: and that the work be done under the direction of the Committee on Water Supply, with Messrs. Shedd & Sawyer as consulting and superintending engineers."

The work contemplated by the foregoing vote having been completed, with the exception of some minor matters to which reference is made hereafter, the Committee would respectfully submit their report, together with the report of the consulting engineers.

Immediately after the adjournment of town meeting, noticed above as of June 11, the Committee organized by the choice of Mr. Henry M. Whitney, Chairman, and Mr. F. Hunnewell, Secretary.

Messrs. Shedd & Sawyer, engineers, were notified of the action of the town, and called upon for plans and specifications of the work proposed, in accordance with their report to the Committee, under date of March 15 and 29, and which has also been submitted to the town in a former report.

From the site selected for the location of the new Pumping Station to the point where the main would meet the present line of conduit, it was necessary to pass over a short piece of land owned by Mr. N. M. Morrison. This right of way was obtained by the payment of one hundred ($100) dollars, and some accommodations in relation to the use of water for his own domestic purposes, with a release of damages and conveyance of the right to maintain the conduit, and to enter for any purpose connected therewith.

Letters were addressed to several parties, soliciting bids for the 16-inch main, which resulted in closing a contract with Messrs. R. D. Wood & Co., of Philadelphia, for three thousand feet of 16-inch iron pipe, at $25\frac{70}{100}$ per ton of 2240 lbs., delivered at the Spring Street Station on the Dedham branch of the Boston & Providence Railroad.

It was decided by the Committee, as there was to be a superintendent upon the ground all the time night as well as day, that all the material to be used in the pump well, screen chamber filter gallery and foundations for engine house, should be purchased by them, and the work done by the day, with the exception of laying the stone foundations of the house and for foundations of the arch of the filter gallery, which was contracted for by the perch.

In pursuance of this decision, contracts for materials were made as follows: Sixty thousand bricks, at $\$8\frac{45}{100}$ per M; five hundred casks of cement, at $\$1\frac{20}{100}$ per cask; 320 perch of stones, at $\$1\frac{55}{100}$ per perch, and the necessary lumber, at

$14\frac{25}{100}$ per M, all to be delivered on the ground—a schedule of which may be found in the appendix of this Report.

A contract was entered into with Felix Johnson, Sen'r., he giving the lowest figures for the same, for laying all the stone foundations in filter gallery, and for the engine house, as specified, for $1.00 per perch; a slight concession to which price was subsequently made for the stone laid in the filter gallery. And in view of many delays and difficulties he had necessarily to encounter, it is but just that special mention should be made of the *substantial* and *faithful character* of this important portion of the work.

At the request of the Committee, propositions were submitted by Messrs. H. R. Worthington and Wm. E. Worthen, of New York, for the new *relief engine.* Each appeared before the Committee to explain the peculiar advantages of their respective pump, neither of which could be furnished for a less sum than three thousand ($3,000) dollars.

But owing to the fact that it was thought desirable the two engines should be similar in construction, and as the engine (Worthington) now in use had given, from the day it was put to work to the present time, the most unqualified satisfaction, it was decided to execute a contract for a Worthington pumping engine capable of pumping one million gallons in twenty-four hours, for the sum of three thousand ($3,000) dollars, substantially as set forth in his proposition on file, under date of July 16, 1879.

Three propositions were submitted for furnishing the new boiler, viz.: Messrs. Kendall & Roberts, and Cunningham Iron Works, and the Whittier Machine Co., and the contract was awarded Messrs. Kendall & Roberts, for the sum of $848.00 this being the lowest bid, which provided for its being delivered upon the ground at the new Pumping Station.

In the meantime the labor was pushed forward at Cow Island, — clearing up the ground, constructing the new roadway from the line of Morrison's land to the site of the building, and excavating for the pump-well and the screen chamber.

The dimensions of the excavation for the pump-well were 31 feet in length, 19 feet in width, and 18 feet in depth ; and for screen chamber, 11 feet in length, 9 feet in width, and 17 feet in depth. After sinking about ten feet, water was met in large quantities, and one of the portable engines was started up to drain the ditch. The digging was through coarse, clean gravel the entire distance, and the work rapidly done, using sheet piling to confine the gravel at each side and end.

Subsequently, two engines, one pumping at each end of the excavation, were required to keep the water away from the men at work within. On the 26th of July the brick bottom was commenced in the well — laying double rows in cement — and notwithstanding the two pumps at work were raising out of the ditch nearly, if not quite, 1,500 gallons of water per minute, — pumping night and day during just this stage of the work, — yet the work was uninterrupted even for a single hour, and the men and brick were as dry as if at work on the surface. And this was true all through the construction of well and screen chamber, and is worthy of special mention, inasmuch as it assures the perfect adhesion of the cement, making a solid and impenetrable wall of brick and cement, to resist the water when the time should come to let it in. Adjoining the pump-well and connected with it by a brick conduit, in the end of which is the large gate, is the *screen chamber*. These (the pump-well and screen chamber) stand at right angles with the new section of the filter gallery. In the screen chamber are placed the screens, which run in a groove left in the brick

work, and which fall on a stone weir, over which the water must flow in its course from gallery to pump-well. And as this weir is raised several inches above the bottom of the gallery, it acts as a protection against gravel or any other heavy matter getting in to check the flow or contaminate the water in the well chamber.

While laying up the brick work in the above excavations were going on for the new filter gallery to connect in a direct line with the east end of the old galleries. To guard against the large influx of water which retarded the work when the old galleries were constructed in 1874, only a small section of about twenty-five feet in length were opened at a time, with bulk heads in the ends. By this method no difficulty was experienced in keeping the water down, and allowing the masons to prosecute their work in comparative comfort. This gallery, which is 1664 feet long, is laid up with a solid foundation of heavy stone and cement, two feet high and two feet wide, from which one brick wall springs six feet high, and six feet wide at the base with double rows of brick, which, as will be observed, is two feet higher and two feet wider than the old galleries. It is also four feet lower in order to get the pumps as low as the floors of Chester River will admit, and to utilize a lower stratum of water bed. An excavation, for this gallery, was necessary to cut through and disconnect the wooden conduit from the old gallery, during which time the water supply to the town will be kept up by pumping with one of the portable engines from the river pump pit (which was now covered and connected with the old conduit below where the brick work ends).

[illegible] from the above excavation [illegible] a very large amount of water [illegible] a second engine was [illegible]

the water from the excavation at the western end of the new gallery but 150 feet away: and on the 7th of August, at noon, the following comparative temperature was taken:— Atmosphere, 74°; water of Charles River two feet below the surface, 81°; water in old filter gallery, 50°; water in new pump well, 49° Fahrenheit.

In making connection with the old gallery, a portion of the man-hole and a few feet of the gallery had to be taken down and relaid, first, in order to make the connection strong, and also because the brick-work was found to be in a rather rough condition, as though it had either been put up in great haste, or the foundation had been in some way disturbed.

On the 9th of September digging was begun for the 16-inch main, which had now arrived on the ground, commencing with the end nearest the new station. By the courtesy of Mr. Jones, Superintendent of the Eastern Division of the Cochituate Water Works, a caulker from the Boston force was engaged to assist the one connected with our own works in making the lead joints of the new main. Connection was made with the old Pumping Station on the 3d of October.

As a demand was made by the water takers of the town, that the new source of supply should be utilized at as early an hour as possible, it was the purpose of the Committee, immediately upon the completion of laying the main, to place a temporary pump over the new *pump well*, and force the water through to the old station.

But a better and a more economical plan was suggested by our engineer, Mr. Flynn, which was, to make a suction pipe of the new main, and with our engine at the old station, draw the water from the new gallery.

This plan receiving the endorsement of our consulting engineers, was adopted; and on the 8th of October water

was delivered to the town, from the new pump well, through the new main, and the old wooden flume forever abandoned.

On the 27th of September, the bids were opened for furnishing material above foundations, and building the new Pumping Station, in accordance with plans and specifications furnished by the engineers. Four bids were submitted as follows:— Horace James, eight thousand ($8,000) dollars. Jos. W. Coburn & Co., seventy-seven hundred and eighty-four ($7,784) dollars. J. M. Russell, seventy-seven hundred and fifty ($7,750) dollars. Felix Johnson, Jr., sixty-three hundred and seventy-five ($6,375) dollars.

Subsequently, the latter bid was withdrawn, and the contract given to J. M. Russell, a proper bond being furnished satisfactory to the Committee, and the work was begun on the 1[illegible]th of [illegible].

Owing to the fact that with the pump in the old location, it was unable to draw the water down in the old filter galleries to a lower depth than about 2½ feet even in the dryest times, leaving an open space of only about 18 inches, it has been impossible for the Water Commissioners to enter them for the purpose of inspection or repair, until the completion of the new gallery, which being [illegible] lower, would allow the others to be drained into it. Even the resident engineer on the works at the time they were constructed, and whose duty it was to inspect the work as it progressed, admits that he never entered the galleries after they were completed; and owing to the small space and the amount of water, did not deem them safe to enter. He could only inspect them so far as daylight would throw its dim light into them, from a manhole or other opening. With the water drawn nearly out of these galleries as described, an inspection was thought necessary by the Committee, and a party, each furnished with [illegible]

man-hole at the intersection of the old with the new gallery, going through the eastern section, 271 feet, of the old gallery, finding the brick work and foundation in tolerable condition. Between this and connecting the western section, is a wooden flume, like the one across the meadow, 389 feet long. Entering the man-hole again at the east end of the western section, the inspector was confronted within twenty feet, with an impassable barrier, and was obliged to return. Men were immediately put to digging to uncover the gallery; they soon encountered pieces of old plank, broken Akron pipe and large quantities of brush, tumbled in as if in great haste, and under all lay the bricks of the fallen arch.

The Committee have endeavored to find the party responsible for this gross fraud, but without satisfactory results. The Board of Water Commissioners having in charge the construction of the works, the engineer-in-chief, the contractors, foreman and inspector, deny any knowledge upon the subject. The work of repairing this break, coming more properly under the charge of the Water Board, was immediately taken in hand by them, the debris removed, and the arch firmly replaced. A man-hole, which seemed to be of prime necessity, was built at the extreme end of this, the western gallery, which now leaves all the galleries in good shape for any future inspection.

This completed all the work below the grade, about the new station, except some finishing touches upon the drive-way, which must neeessarily be left until frost is out of the ground in the spring. And at this point it may be of interest to refer to the fact, that all the materials used were contracted for at the lowest figure of cost they have touched for many years, if ever before, in this country; and again, from the time ground was broken for the new pump-well in June,

until the foundations for the station were in, and the 3,60 feet of 16-inch main laid and connected at the old stat October 3d, the work was impeded less than forty-eight hou by inclement weather, or any other casualty.

Reference has been made to the intermediate conduit whi is a wooden flume connecting the two sections of galleric laid across a piece of land 389 feet in length, of a marsh nature. While we think the leakage of swamp water in the conduit is very slight, yet your Committee regard within the range of their duty to suggest that, at no di tant day, a gallery similar in size and construction to t one just completed, be substituted for this flume, conne ing the other galleries, and thus remove the only possi source by which our water supply can receive the le contamination.

In January, 1880, the relief engine was connected with t boilers now in position and the building ready to receive t finishing touches on the inside.

As soon as the proper connections with the boiler and for main could be made, the *new Relief Engine* was put in serv and the old engine and boiler disconnected and got ready removal to their new position.

The *new pump*, as will be noted by the terms of the contr with H. R. Worthington, its makers, was tested a pump capacity at the rate of one million gallons in twenty-f hours; but it has proved upon trial for many consecutive d capable of pumping at the rate of one and two-thirds million gallons for the twenty-four hours, with a stroke of 160 to minute and running with perfect smoothness. As an elem of assured safety, in case of accident to the larger pumps, value and importance of the addition of this relief pump to town's water supply, can scarcely be overestimated.

During the month of January, 1880, bids were solicited, and three were obtained, for rebuilding the engineer's residence, in accordance with plans and specifications furnished by the engineers, Messrs. Shedd & Sawyer, using the material, as far as practicable, from the old pumping station.

But on opening the bids, and after a very careful consideration of the whole matter, it was deemed advisable by your Committee to postpone further action on this building, in main, for the following reasons: — First, — All the bids were considerably above the figures at which it was originally calculated the work could be done for. Second, — As all the outstanding bills on the work were not on file, it could not then be determined just what portion of the appropriation could be used for this purpose. Third, — With the view of modifying the plans somewhat, to reduce the cost, and with the hope that the work may be done for less the coming season.

Save the construction of this building, the setting up and connecting the old engine and boiler, all the important work, the supervision of which was entrusted to your Committee, is complete. And it must appear that the points attained by the undertaking, namely: an ample water supply, under any contingency likely to occur, and that, too, for many years to come, and of a quality unsurpassed for its purity, more than compensate for the liberal outlay the town has incurred.

HENRY M. WHITNEY.
WILLARD A. HUMPHREY.
WM. H. LINCOLN.
OLIVER WHYTE.
WILLIAM GRIGGS.
FRANCIS HUNNEWELL.

Special Committee on Water.

SUPPLEMENTARY REPORT.

The members of the Committee, not members of the Water Board, beg to call the attention of the town to the following vote, passed June 11, 1879, as follows, viz:

Voted "That with a view to their compensation, the said Committee be requested to keep a record of their meetings and of the attendance of the several members, and the time spent by the several members in this service of the town."

The details of the work have been performed by the members of the Water Board. It has required very constant attention by some member of the Board throughout the entire progress of the work, and will continue to do so until all is completed, and in our opinion, the work has been performed with great fidelity to the trust, and with good judgment.

We think the sum of Fifteen Hundred Dollars should be appropriated as the compensation contemplated by the above vote of the town, and recommend the passage of the following vote:—

"*Voted*, That the sum of Fifteen Hundred ($1,500) Dollars be appropriated as compensation to the members of the Water Board for their services in attending to the repairs of the water works."

The Committee furthermore ask, as all the most important work has been completed, that the finishing be left with the Water Board, under the supervision of the present engineer, and that they (the undersigned) be discharged from further duty.

HENRY M. WHITNEY,
WILLARD A. HUMPHREY,
WILLIAM H. LINCOLN.

REPORT OF THE ENGINEERS.

PROVIDENCE, March 23, 1880.

Messrs. WHITNEY, LINCOLN, HUMPHREY, WHYTE, HUNNEWELL and GRIGGS, Special Committee on Water Works of the Town of Brookline.

GENTLEMEN: We make herewith a report of progress of the work upon the New Pumping Station, in accordance with your request.

Water was supplied from the new gallery to the town reservoir, through the old engine, on the ninth day of last October, at which time all contamination by swamp water ceased. Since then, the supply of pure water to the town has been uninterrupted. This supply was accomplished by connecting the new line of 16-inch iron pipe, which had been laid across the swamp for the future force main, temporarily with the engine, to use as a suction pipe, and extending the other end into the new pump-well on Cow Island, which received its water from the new gallery. This suction pipe was about 2,900 feet long. It had a check valve in the pump-well and an air chamber about 15 feet high near the engine. By connecting this air chamber with the air pump of the engine, so that the surplus air relieved from the water at every stroke of the engine could be drawn off at pleasure, this enormous suction pipe — unprecedented, so far as we

know, for size and length — was made to work very satisfactorily in its temporary use. Mr. Flinn is entitled to credit for his clever management of this pipe in his daily pumping.

The new engine, erected at the new station on Cow Island, began pumping into the town reservoir on the sixteenth of February, forcing the water through the old engine until the afternoon of the twentieth, when the reservoir, which had lowered during the four days required to connect the new engine, was sufficiently filled. The old engine was then disconnected and the new force main was laid by the old station and connected with the old force main.

Pumping into the reservoir through the completed force main was begun on the first of March.

The old engine and boiler are in process of removal from the old station to the new.

The difficult and dangerous work, including the new gallery, screen-chamber, pump-well, force-main and connections, and engine house with foundations, is completed.

It remains to remove and place the old engine and boiler in position at the new station, and connect them with the other work; to finish the engine house; and build a dwelling house for the engineer.

The work on the ground at Cow Island was begun on July 1, 1873, by a few men who cleared the ground and opened a temporary road. The regular gang of laborers for the work of construction was organized on July 9; and after that time the work went regularly forward. When the excavation for the pump well was started, July 21, the gang numbered forty men.

The original surface of the ground above the pump well was at about elevation 87.00 above mean high water of Boston Harbor. The first four feet of depth was through loam and a mixture of sand and loam. The next three feet in depth was

fine, dry sand. At this depth sharp wet gravel was struck, and pumps were needed to keep down the water. The excavation was continued through the sharp gravel to elevation 70.00. At this depth two steam pumps were required, and they discharged by estimate 700 gallons of water per minute.

The brick-work was begun July 28, and the pumps were run day and night until the brick-work was completed and firmly set.

The pump-well has an egg-shaped section, large end down, and is 6 feet wide and 7 feet high in the clear, with 12 inch thickness of walls. It is 26 feet long inside. Its axis is 7 feet inside the inner face of the front wall of the engine house. Two elliptic brick shafts, 6 feet by 4 feet across, rise from the well to accommodate the suction pipes for the two engines. A sump, to facilitate clearing the well of water, has a shaft over it for access to the pipes used for feeding the boilers and charging the engines. The shafts rise to the level of the engine house floor or 89.92 ; the top of the floor being 90.17.

The pump-well is fed through a 2-feet circular conduit connecting with the screen chamber. The low water level in the pump-well is at elevation 73.75 ; the bottom of the well being 71.35.

Two 6-inch iron pipes are set vertically near the south-west corner of the pump-well to serve as gauge pipes. One is connected with the pump-well and the other with the river by small lead pipes. As the water rises or falls in the river or the pump-well, the water will follow in the gauge pipes, and floats with proper rods divided for the purpose, will indicate upon gauges in the engine room the heights at which the water stands.

We have kept records of the height of Charles River during our work and found that the surface fell below what has been

called low water; on October 27, when it reached 80.30, and on November 3, when it reached 80.20. On December 1, it stood at 80.50 or just low-water level as her tetore assumed.

The conduit is laid in gravel similar to that found in the pump-well except through a pocket or vein of clay about 12 feet across and 4 feet deep. This clay was dug through, at elevation 71.00, and the brick-work laid on gravel. The interior invert of the conduit is at elevation 72.05, and the interior crown 74.05. The length is 25.8 feet.

The conduit is connected to the new gallery through a screen chamber, for which the excavation was carried to 71.00 through material about the same as at the pump-well. The chamber is built of brick, founded upon a plank platform four inches thick, in two layers laid across each other and resting upon 6 × 6 in. cross-timber at each end. The top of the platform is at elevation 71.38. The chamber is four feet in the clear each way, with 20-inch brick walls rising to elevation 87.74 and capped with dressed granite. The granite coping is twelve inches thick, making the top at elevation 88.74. The well is covered within the coping by a hard-pine cover in two pieces, held in place by brass bolts and nuts. Grooves for screens and stop planks are built in the masonry walls and an iron and composition valve, thirty inches in diameter, is set in position to cut off the connection with the conduit. On the opposite side of the chamber a granite weir is set at elevation 73.30, over which all water from the gallery must pass. This weir prevents drawing down the water of the gallery to an extent which would endanger its stability. Above the weir is an arched opening into the gallery, 3 feet wide and 5 feet high, through which men may pass into the gallery when necessary.

The screen chamber, pump shafts, and man-holes to the gallery are provided with cast iron steps built into the masonry for convenience of access to the work.

The excavation for the gallery was begun July 30. The trench was opened 11 feet wide and excavated to elevation 72.00. Water was reached at about 80.00 and was controlled by the steam pumps. The open bottom of the gallery for its whole length, with one or two exceptions, is in a natural bed of clean, sharp gravel. The exception is as follows: two or three springs of boiling sand were found about 80 feet west of the screen chamber, which were excavated to a depth of 3 feet below the bottom of the gallery, and filled with good gravel. This effectually holds the sand back while letting the water pass through freely. The centre line of the gallery is about 50 to 52 feet from the centre line of the engine house, being nearest at the screen chamber.

The bottom width, in the clear, is 6 feet and the height in the middle is 6 feet.

The crown is a brick arch 8 inches thick, turned over stone walls 2 feet thick and 2 feet high, forming side walls. Both stonework and brickwork are laid in cement mortar.

Struts of 6 x 8 in. timber are laid in the bottom, at intervals of 6 feet, and being notched, to pass partly under and partly against the faces of the side walls, serve to aid the walls in resisting a side pressure of the exterior earth. The tops of the struts are level with the finished bottom of the gallery, or at elevation 72.50. The bottom level of the stone side walls is 72.00, or six inches below the bottom of the gallery.

In July the old wooden box conduit leading across the swamp to the pumping station was opened near our work, and the water raised by one of our drainage pumps was turned into it. It was observed that this had the effect to materially increase the quantity and improve the quality of the water received at the old pumping station. The drainage pump was worked whenever the Worthington engine was run, and after

the new pump well was finished, a temporary well was established to keep the drainage pump supplied. On Sept. 7 a connection was made between the new gallery and the old box conduit, so that the conduit was supplied from the gallery by gravity, and the drainage pump was stopped. While in operation this pump supplied — as an average of several measurements — 250 gallons of water per minute, or about half a million gallons per day.

The junction of the new gallery with the old east gallery was made through an old man-hole. The level of the bottom of the old gallery is 74.50, or two feet higher than the new gallery, and a part of the fall necessary to connect the two could conveniently be made in the man-hole.

When the side of the man-hole was uncovered to make the connection, the brick-work was found to be misshapen, rather loose and apparently insecure. Adding to this the statements of former employes to the effect that the wooden platform shown upon the plans as underlying the masonry had been left out, and that subsequent attempts had been made by a diver to place a floor in the man-hole, under water, with indifferent success, we were led to doubt the security of the foundations against the flow of water from one gallery to the other, with a fall of two feet in so short a distance, if made according to our original plan based upon the belief that a platform had been constructed. It was not a place where the town could afford risks and we therefore cut off the old gallery above the man-hole and sunk a puddle wall, faced with sheeting, 5 feet below and 14 feet wider than the old gallery. This it was believed, together with the timbers at first designed, would secure the work against the passage of sand along the foundations, even in the absence of a platform. As the work progressed, after the cut-off had been made, and the foundations were more com-

pletely uncovered, we had reason to believe that a platform, not quite so large as shown on the plans, had been originally laid under the man-hole and it is possible that the work might have been secure if it had been made according to our first plans and without the cut-off, which cost about $320. However, the cut-off is an additional security, and perhaps worth making as such, especially as the old masonry was not as sound as anticipated.

The old man-hole had a brick wall running across the gallery and rising half a foot above its bottom, on which stop-planks could be placed to hold back the water of the gallery in case the conduit needed to be emptied. Below this wall was a pit 2 feet deep, 4 feet long and 3 feet wide, into which the water from the gallery fell after passing over the wall.

The bottom of the pit was intended to be at elevation 73.00, and was found to be 5 or 6 inches lower. The bottom of the conduit connecting with the pit was at elevation 75.00. We removed the conduit and cut down the walls so as to make a weir with rounded surface faced with stoneware at elevation 74.00. Below this weir we drove strut piling quite across the work, and about 6 feet deep.

Beyond this a stone wall was laid across the work, 2 feet wide and 2 feet deep, having its surface at elevation 73.50. Beyond this a broken stone bottom for the new gallery was laid, beginning 2 feet thick and running to half a foot thick in 8 feet distance; the surface being at elevation 73.50 next the wall and falling to 72.50 where it joined the general gravel bottom of the new gallery. A stop-plank of any desired height can be maintained in the man-hole to hold back the water of the old gallery at a proper level to prevent injury to that work.

By passing through the construction above described, the surface of the water can fall harmlessly to the level of the new

gallery, and the underground passage is so checked that no injury can be done.

Needed repairs were made to the old man-hole. The plank bottom would neither keep out sand nor water, and a 3-inch layer of cement mortar was spread upon it, after spikes had been thickly driven to make a reliable attachment of the cement to the wood. This made a tight and apparently secure bottom, and as the spikes are entirely encased in wood or cement, they probably will not oxydize. The brick-work was repaired, pointed and plastered with cement to elevation 85.50. The granite coping was dressed into symmetrical form, and the wooden cover replaced by a North River flagging and circular iron cover taken from the old conduit. The whole being raised 16 inches by building up the brick side walls, and set at elevation 88.50. Iron steps were built into the interior walls of the man-hole to facilitate access.

The man-hole at the east end of the west gallery was repaired, pointed and cemented; the granite coping dressed and supplied with a stone and iron cover similar to that on the first man-hole, iron steps set inside, and the whole put in good condition. The cost of the work on both these old man-holes was $118.57.

West of the first man-hole, for a distance of 16 feet, the old gallery was found to be in bad condition, and it was relaid at a cost of $120.32.

From the condition of the work where it had been exposed we were led to examine the condition of the interior of the old gallery throughout its length. The earliest convenient opportunity for such examination on account of the state of the work and consequent height of water in the gallery was on the first day of November. The water was then held at elevation 76.00 by the Worthington engine, and a workman was sent into

the galleries. He reported for the east gallery: two holes in stone-work on the south side about 50 feet west from the first man-hole; one boiling spring of running sand about 100 feet from the man-hole; two holes on the north side, near the boiling spring; three old cement tubs partially decayed; the arch in fair condition for the whole length; more or less sand was found along the whole bottom. The cement tubs were removed but the defects have not been repaired, for the reason that the Worthington engine in its present location could not hold the water low enough. With the engines in position in the new station we think this can be readily done.

The west gallery was found in fair condition for a distance of 30 feet from the man-holes. At this point the arch had fallen in and a complete barrier to passage existed. The water beyond was dammed up, and flowed over or trickled through the obstruction to a limited extent.

On the third of November the gallery was opened at this point from the surface. It was found that from a point about 35 feet west of the man-hole to a point about 18 feet further west, the arch must have fallen in at the time of construction. Instead of rebuilding this fallen arch, the gap had been filled by laying eight or nine 2-feet lengths of 24-inch Akron stoneware pipe with such degree of continuity as was practicable, and covering them. The sheeting had been left standing. As a protection to the pipes, cross-pieces of 2-inch planks, 8 inches wide, were placed about 6 feet apart and resting on the rangers of the sheeting. On these cross-pieces a platform of sheeting plank 12 to 15 feet long had been laid, running lengthwise of the gallery. Above this platform was a layer of brush about 1 foot deep. Above the brush was another platform made up of shorter pieces of sheeting plank thrown in without order. Upon the double platform thus constructed, the trench

had been back-filled. The cross-pieces were all found broken in the middle and resting on the crushed pieces of stoneware pipe. These breaks in the cross-pieces were old, indicating that the platform had sunk a long time ago, and probably soon after the trench was back-filled. Both ends of the brick arch where standing, were badly pressed out of shape. It was estimated that in the double platform, about 18 feet long and 6 feet wide, there was found 800 feet of lumber.

The effect of this break was to fill the gallery for a length of about 18 feet with debris of brick, broken pipe, lumber and gravel, thus rendering nearly all of the west gallery practically useless as a source of water supply.

The length of the east gallery was 271 feet, and of the west gallery 491 feet, or a total of 762 feet. By the obstruction about 400 feet of the west gallery was cut off.

The break was repaired by building 50 feet of new arch from a point 10 feet west of the man-hole to a point 60 feet west of it.

The remainder of the gallery was examined November 7. Three breaks were found in the stonework, which was generally in very bad condition. These breaks were repaired. One boiling spring about midway of the gallery was found running black mud. Some 150 cubic feet of this mud was taken out and replaced with gravel.

The bottom and sides of the gallery were found coated with a very light and red vegetable matter. This was stirred up and mixed with the water and so pumped out. 11 feet from the westerly end of the gallery a new brick man-hole was built, making it possible for a man to pass through the gallery without being obliged to return to the extreme easterly end to get out. It was covered at elevation 88.00 with a heavy iron man-hole cover without a frame. Steps were built into the inner wall to

in the other man-holes. As the man-hole shaft rose above the natural surface, it was covered and banked about with earth. The cost of the repairs, etc., was paid by the Water Commissioners and amounted to $305.79. The work was completed November 16, thirteen days after starting.

THE ENGINE HOUSE.

The work on foundations at the new engine house was begun August 13. The pits for the foundations of the engines were excavated to elevation 73.85, and the stonework begun at that level. The last five feet depth of excavation required pumping. One hundred perches of rough granite were laid in cement mortar in the two pits. Three hundred and nineteen perches were laid in the other foundations about the building. All the foundations rest on good, sharp sand and gravel. This work was completed October 16.

The road leading through the station grounds to the building begins at the end of Grove street on N. M. Morrison's land at elevation 126.31. It winds around the side of the hill on an easy curve falling 7.22 per 100 for a distance of 510.5 feet to elevation 89.44 northeasterly from the engine house. Thence by the east front of the building, falling 8 inches per 100 feet, a distance of 119 feet, to elevation 88.64. Thence continuing around the building, rising 8 inches per 100 feet, a distance of 76 feet, to elevation 89.15 southwesterly from the boiler house. Thence parallel with the side of the boiler house, rising 7.22 per 100 until it intersects the line, making a loop enclosing the building. The road is 20 feet wide except that in front of the engine house it is widened to 26 feet. The surface was gravelled when gravel was not found in place. The side slopes of $1\frac{1}{2}$ to 1 are well graded, soiled and seeded.

The total length of road as built is 805 5 feet. A path 10 feet wide leads to the engine house door, and one 8 feet wide leads to the boiler house door.

The work was practically complete on the first of November. The grounds about the building are well graded and covered with soil, but there remains some work to be done to give the finished effect desired.

SHEDD & SAWYER,
Civil Engineers.

DISBURSEMENTS

FOR

MOVING PUMPING STATION, ETC.

THE following detailed statement exhibits all the payments which have been made to the present time, from the appropriation of $35,000 which was made by the town :—

July	7,	W. H. Olmstead, Repairs,	16 50
Aug.	11,	T. T. Robinson, Sundries,	6 33
		G. W. Twichell & Co. Belting, etc.	53 50
		Oliver Whyte, cash paid for sundries,	2 48
		C. D. Austin, Hardware,	14 42
		Boston Belting Co., Rubber Packing,	5 25
		James Rooney, Rubber Boots,	21 85
		M. C. Warren & Co., Hardware,	10 12
		Fuller Iron Works, Castings,	7 98
		George Curtis, Lumber,	459 95
		E. M. Pratt, Stationery,	1 25
		Dodge, Gilbert & Co., Hardware,	40 35
		Boston & Providence Railroad Co., Freight,	1 22
		R. Woodward, Iron work,	1 48
		Thomas Nagle, "	8 85
		P. Lucas, "	1 50
		O. B. Delano, Carpentering,	65 68
		Kenrick Brothers, Plumbing,	2 25
		M. Withington, Treasurer, Pay roll, laborers,	971 95
		Shedd & Sawyer, Civil Engineers,	500 00

Aug	18,	F. F. Forbes, Car fares, &c.,	4 10
Aug	15,	Welch & McLaughlin, Stone,	100 00
Sept.	1	Felix Johnson, Mason,	95 00
		Boston & Providence Railroad Co. Freight,	237 50
Sept.	8,	C. D. Austin, Hardware,	14 03
		M. Goodspeed, Carriage hire,	8 00
		George Curtis, Lumber,	574 81
		Brookline Water Works, Pipes,	61 26
		James Driscoll, Teaming,	58 00
		Boston Lead Co., Lead,	269 84
		John S. Lyons, Stone,	72 00
		Felix Johnson, Mason,	97 75
		K. D. Wood & Co., Iron Pipe,	2,500 00
		Sewall, Day & Co., Jute, Packing, &c.,	32 47
		Fales & Jenks Machine Co., Castings	166 95
		Manchester & Hudson, Cement,	126 00
		J. Hayes, Teaming,	8 00
		M. Withington, Treasurer, Pay roll, laborers	1,700 28
Sept	15,	F. F. Forbes, Sundries,	34 44
		E. M. Pratt, Stationery,	1 85
		Welch & McLaughlin, Stone,	57 30
		Felix Johnson, Mason,	100 00
Sept.	22,	Welch & McLaughlin, Stone,	50 00
		Boston & Providence Railroad Co., Freight,	140 90
Sept.	29,	Sheild & Sawyer, Civil Engineers,	125 00
		Andrew McKenna, Iron Work,	11 12
		John J. Kane, Iron Work,	9 84
		Manchester & Hudson, Cement,	141 20
		Felix Johnson, Mason,	150 00
		Welch & McLaughlin, Stone,	300 00
Oct	6,	Sheild & Sawyer, Civil Engineers,	400 00
		Howard Stedling & Co., Coal,	278 25

Oct.	13,	R. Woodward, Iron Work,	4 54
		F. F. Forbes, Sundries,	9 20
		C. D. Allston, Hardware,	2 60
		Boston Lead Co., Lead,	10 15
		Brookline Water Works,	5 35
		S. E. Chubbuck & Sons, Machinists,	42 14
		Thomas Nagle, Blacksmith,	17 05
		John Lowell, Telegraph Poles,	22 50
		Samuel Beal, Carpenter,	19 18
		Felix Johnson, Jr, Mason,	40 15
		Holmes & Blanchard, Machinists,	7 20
		James Rooney, Rubber Boots,	3 50
		Dodge, Gilbert & Co., Hardware,	6 32
		Oliver Whyte, Cash paid for Sundries,	4 38
		Felix Johnson, Mason,	133 93
		Welch & McLaughlin, Stone,	100 00
		Charles Williams, Jr., Wire,	24 91
		Brookline Gas Co., Coke,	2 50
		George Curtis, Lumber,	56 26
		James Driscoll, Teaming,	216 00
		Boston Lead Co., Lead,	7 48
		M. R. Warren, Hardware,	5 50
		M. Withington, Treasurer, Pay Roll,	1,521 64
	27,	Felix Johnson, Mason,	47 25
		M. N. Morrison, Grading,	67 17
		M. Withington. Treasurer, Pay Roll,	958 94
Nov.	3,	Boston & Providence Railroad Co., Freight,	240 78
		R. D. Wood & Co., Iron Pipe,	1,633 50
		Shedd & Sawyer, Civil Engineers,	400 00
	10,	G. W. Twichell & Co., Belting,	1 20
		J. Hayes, Teaming,	3 00
		Walworth Manufacturing Co., Machinists,	12 60

Nov.	10,	Thomas Nagle, Blacksmith,	9 10
		Kenrick Brothers, Plumbing,	20 75
		C. D. Austin, Hardware,	3 05
		T. T. Robinson, Sundries,	3 57
	15,	J. M. Russell, Mason,	2,200 00
		M. Withington, Treasurer, Pay Roll,	442 10
		N. M. Morrison, Grading,	33 65
Dec.	1,	J. M. Russell, Mason,	1,000 00
	8,	Fiske & Coleman, Clay Pipe,	48 92
		J. A. & W. Bird & Co., Oil,	36 61
		George Curtis, Lumber	21 40
		F. F. Forbes,	3 [illegible]
		Thos. Cunningham & Sons, Water Pipes,	52 [illegible]
		C. D. Austin, Hardware,	2 20
		James Driscoll, Teaming,	48 76
		T. T. Robinson, Sundries,	[illegible]9
		M. Goodspeed, Wagon hire,	[illegible]0 00
		J. M. Russell, Mason,	700 00
1880			
Jan.	5,	Shedd & Sawyer, Civil Engineers, Plans for Engine House,	400 00
		John S. Lyons, Granite	133 [illegible]
Jan.	12,	Thomas Nagle, Blacksmith,	1 8[illegible]
		Kenrick Brothers, Plumbing,	1 [illegible]
		T. T. Robinson, Sundries,	[illegible]
		Oliver Whyte, Cash paid for sundries,	1 75
		Charles Chase, Express,	3 [illegible]
		Fuller Iron Works, Castings,	54 85
		J. J. Kane, Blacksmith,	4 70
		Kendall & Roberts, Iron work,	10 92
		B. F. Sturtevant, Machinist,	1[illegible] [illegible]
		Fales & Jenks Machine Co., Castings,	[illegible] 75

Jan.	12,	George Curtis, Lumber,	38 40
		Thos. Cunningham & Sons, Pipes,	70 99
		M. Goodspeed, Wagon hire,	3 00
		M. Withington, Treasurer, Pay roll,	845 49
		Brookline Gas Co., Coke,	1 25
		J. M. Russell, Mason,	1,800 00
Feb.	9,	Coolidge & Brother, Sundries,	4 00
		M. Goodspeed, Wagon hire,	7 50
		Fuller Iron Works, Castings,	59 36
		Walworth Manufacturing Co., Sundries,	38 50
		Fiske & Coleman, Clay Pipe,	7 00
		Kendall & Roberts, Iron work,	9 25
		Thomas Nagle, Blacksmith,	11 51
		Kenrick Brothers, Plumbing,	2 97
		B. F. Baker, Painting,	3 83
		Thos. Cunningham & Sons, Pipe,	41 07
		M. Withington, Treasurer, Pay roll,	163 67
		O. B. Delano, Carpenter,	53 46
March	1.	H. R. Worthington, Engine,	2,000 00
		Fales & Jenks Machine Co., Castings,	171 93
March	8.	Manchester & Hudson, Cement,	151 20
		Boston & Providence Railroad Co., Freight,	30 74
		D. Kennedy & Co., Gates,	147 48
		Thomas Cunningham, Machinist,	1 32
		J. M. Russell, Mason,	683 32
		M. Withington, Treasurer, Pay roll,	337 79
March	15.	P. McCarthy, Teaming,	3 00
			$27,780 21
		Balance unexpended,	7,219 79
		Appropriation,	$35,000 00